Wi-Fi Service Level Expectations

Indiana University's Wi-Fi service is one of the largest wireless network implementations in higher education. There are many challenges in delivering this service over such a large geographic area to such a great many and diverse set of clients.

IU wireless clients can expect a good experience for low to medium bandwidth applications in areas with low to medium wireless user populations. These activities include web browsing, checking email, chat, printing, etc. Most wireless locations on campus do not have high user populations, so most locations should yield a good experience. As the number of wireless clients increase in an area, the speed of the network will decrease for all users. This happens during class sessions, sporting events, etc. High bandwidth applications like streaming video or large network downloads will also decrease the speed and responsiveness of the network for all users in an area.

Basic Factors Effecting Service Quality

There are six basic factors that determine the quality of your Wi-Fi experience:

- 1. The installed infrastructure in an area (i.e., the number of wireless access points).
- 2. The number of wireless clients in an area.
- 3. The types of clients in an area.
- 4. Limitations of the Wi-Fi protocols.
- 5. The level of radio interference in an area.
- 6. An individual client's wireless hardware and software.

UITS can modify the wireless infrastructure, but cannot easily modify the other factors. The protocol and regulatory limitations are fixed.

There are two basic types of wireless service supported on IU's campus: 802.11b/g (2.4 GHz) and 802.11n (5 GHz). A single access point can serve approximately thirty 802.11b/g (2.4 GHz) clients and fifty 802.11n (5 GHz) clients. This limit is primarily a result of Wi-Fi protocol design.

Increasing the number of clients supported in an area is not as simple as adding additional access points. A maximum of three 802.11b/g (2.4 GHz) radios can be installed in close proximity. The limit of three neighboring 802.11b/g radios is due to the number of available non-overlapping wireless channels (2.4 GHz band) allocated by the FCC and supported in Wi-Fi products. Adding more than three 802.11b/g radios in close proximity will generally decrease network performance. This means a maximum of roughly ninety 802.11b/g (2.4 GHz) clients can be served in any given area.

More bandwidth is available when using the 802.11n protocol in 5 GHz, so more clients can be reasonably supported per radio. However, many wireless clients on campus are not 802.11n capable, and many that are choose to use 802.11b/g 2.4 GHz due to poor software implementation on the client. There is a limit of four non-overlapping 802.11n (5 GHz, bonded) channels that do not have special FCC requirements. It is possible in some cases to install eight access points, but that involves trade-offs and risks that are difficult to explain briefly. In the general case, this means a maximum of 200 802.11n (5 GHz) clients can be supported in any given area.

Wireless is a "shared medium," which means that the clients in an area are sharing bandwidth. The bandwidth resources are finite, so as you increase the number of clients in an area, the network becomes slower for all clients. There is no fairness mechanism built into the Wi-Fi protocols, so it is possible for a single client to consume much of the available bandwidth. One implication of this is that signal strength and "connection speed" do not sufficiently reflect what a client's Wi-Fi experience will be like. A few wireless clients in the vicinity could be consuming most of the available bandwidth in an area, so that other clients with a strong signal and high connection rate

experience slow performance. Nearby clients can be on floors above and below. This shared allocation of bandwidth resources is by protocol design.

Additionally, there is no mechanism to equally distribute clients across multiple access points. If forty wireless clients are in an area with two access points, it is very possible for one access point to be serving thirty clients and the second access point to be serving only ten. The user experience for the group of ten will be much better than for the group of thirty.

The types of clients (802.11b, 802.11g, and 802.11n) effect the user experience, as well. For example, one 802.11b client will slow down all 802.11g and 802.11n clients using 2.4 GHz frequencies.

Interference also plays a major role in the quality of the user experience. The radio frequencies used in Wi-Fi are also used by many other types of devices. These devices include cordless phones, wireless headsets, wireless microphones, wireless cameras, etc. When these devices are in operation in the same vicinity as a Wi-Fi network, they can cause interference. Interference can also come from sources such as microwaves. The presence of interference can result in a client showing a connection but not being able to perform network operations, slowing down network operations, or completely disconnecting the client from the wireless infrastructure. Interference is often transient, which makes it difficult to find the source

Wireless client software and hardware also play a significant role in your Wi-Fi experience. Radio characteristics and power vary greatly across client types. It is possible for two different Wi-Fi devices right next to each to have very different Wi-Fi experiences. Client drivers (software that control client radios) have historically been a major source of wireless problems.

The primary factor that UITS can change is the number and placement of Wi-Fi access points. The initial Wi-Fi deployment on campus was designed to maximize coverage area without addressing capacity. Over the years, the number of devices on the wireless network has grown significantly (there are now approximately ~4,300 access points at IUB and IUPUI). UITS continues to build out infrastructure to increase capacity as funding allows. However, the work is not finished and this will continue to be an ongoing effort.

What is UITS doing to help?

UITS is working on several strategies to improve the wireless service.

- 1. UITS is upgrading every Wi-Fi access point during the Summer of 2011 to support 802.11n in the 5 GHz band. This will significantly increase the basic capacity of every Wi-Fi location on campus, providing an improved Wi-Fi experience for many clients.
- 2. UITS is continuing to expand the number of access points in high user areas to help alleviate wireless congestion.
- 3. UITS is working with IU's wireless vendor (HP) to steer clients that are capable of 802.11n 5 GHz operation away from 802.11b/g 2.4 GHz. This effort cannot fully mitigate for poorly written client drivers, but it will help alleviate congestion in the 802.11b/g space.
- 4. UITS is working with IU's wireless vendor (HP) to evenly balance clients across access points in the same area using vendor proprietary strategies.
- 5. UITS is maintaining a relationship with IU's Center for Innovative Teaching and Learning, so that we can improve communication and service to faculty.
- 6. UITS will be performing a thorough Wi-Fi capacity and coverage assessment to help identify problem areas.

How to Maximize Your Success when Using Wi-Fi

Although there are many challenges for large groups of Wi-Fi users in a given area (such as a classroom), there are many things you can do to maximize your potential for success.

- 1. Contact UITS regarding the Wi-Fi capacity of your classroom. If you plan on your students using Wi-Fi in the classroom, please contact UITS with the classroom location and class size. UITS should be able to make a preliminary assessment of the number of Wi-Fi clients your classroom should reasonably support. You can contact UITS with this question for both IUB and IUPUI campuses by sending email to netdata@indiana.edu.
- 2. Do not predicate time sensitive activities on use of Wi-Fi. There are many factors that go into the reliability and available bandwidth of the campus Wi-Fi service, most of which cannot be centrally controlled. Wi-Fi clients in adjacent hallways and classrooms (including above and below) can consume the bandwidth of access points servicing your classroom. Service interruptions from interference will likely not be resolved during your class. It is best to have a backup plan. Wireless should work most of the time, but due to nature of the medium, it is not possible to guarantee service availability. UITS does not recommend using wireless to deliver tests.
- 3. **Turn off unnecessary clients.** Ask your students to turn off or put to sleep smart phones (such as iPhones and Android-based phones), iPods, and any other Wi-Fi enabled devices that are not being used as part of the class.
- 4. **Encourage the use of 802.11n (5 GHz) clients.** The 802.11b/g client space is generally more congested and traditionally has more sources of interference, so UITS encourages everyone use 802.11n (5 GHz) capable clients. Many mobile clients such as phones and tablets support 802.11n only in 2.4 GHz frequencies, which is not supported on IU's campus. For example, the iPad2 supports 802.11n 5 GHz operation, but the HP Slate 500 only supports 802.11n in 2.4 GHz. Both devices will work, but the iPad2 will have a much better Wi-Fi experience using 802.11n, while the HP Slate 500 will be using 802.11b/g.
- 5. Encourage students to update wireless drivers. The driver is the piece of software that controls the operation of the Wi-Fi radio on the client. Many issues can be resolved by upgrading to the latest version of software. Client issues are among the top reasons for wireless service problems, especially in large enterprise environments.

What to do when Wi-Fi doesn't work?

If you are experiencing a Wi-Fi problem, please contact the Support Center (24x7) in one of the following ways:

Bloomington: 812-855-6789
Indianapolis: 317-274-4357
Live Chat: http://ithelplive.iu.edu/

• Email: ithelp@iu.edu